

# Astrobee

## Space Station Robotic Free Flyer



POIWG #50

July 28, 2016

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Intelligent Robotics Group



# Project Summary

- Develop, test, deliver 2 free flying robots for ISS IVA use
- 3 year project (FY15-FY17) under Human Exploration Telerobotics 2 (HET2)
- 1 year (FY18) extension for on-orbit commissioning (proposed)
- Sponsor: Space Technology Mission Directorate, Game Changing Development Program
- Technology infusion to ISS payloads & operations





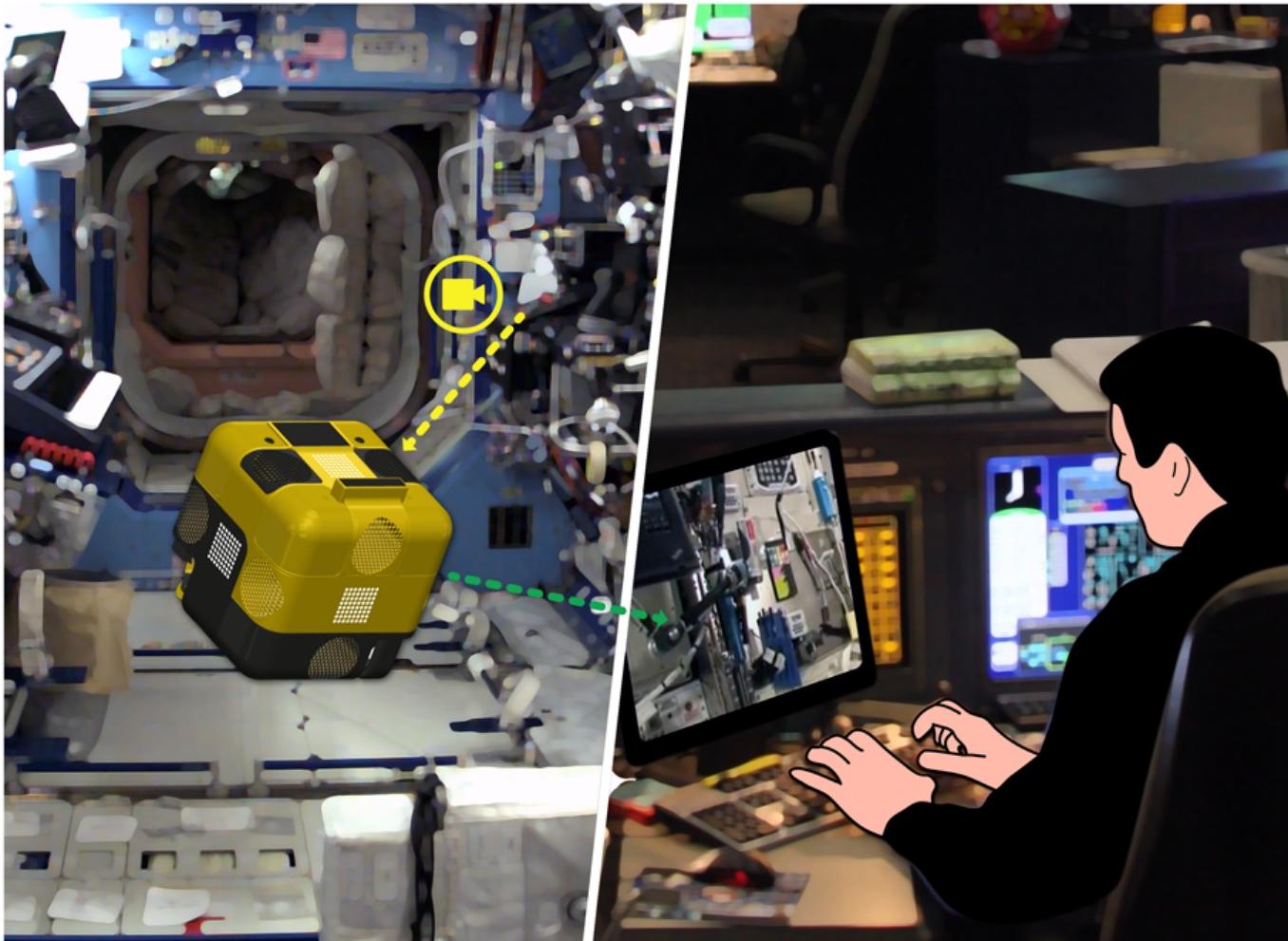
# 0g Robotics Research Facility



AES, SPHERES Program, SPHERES users



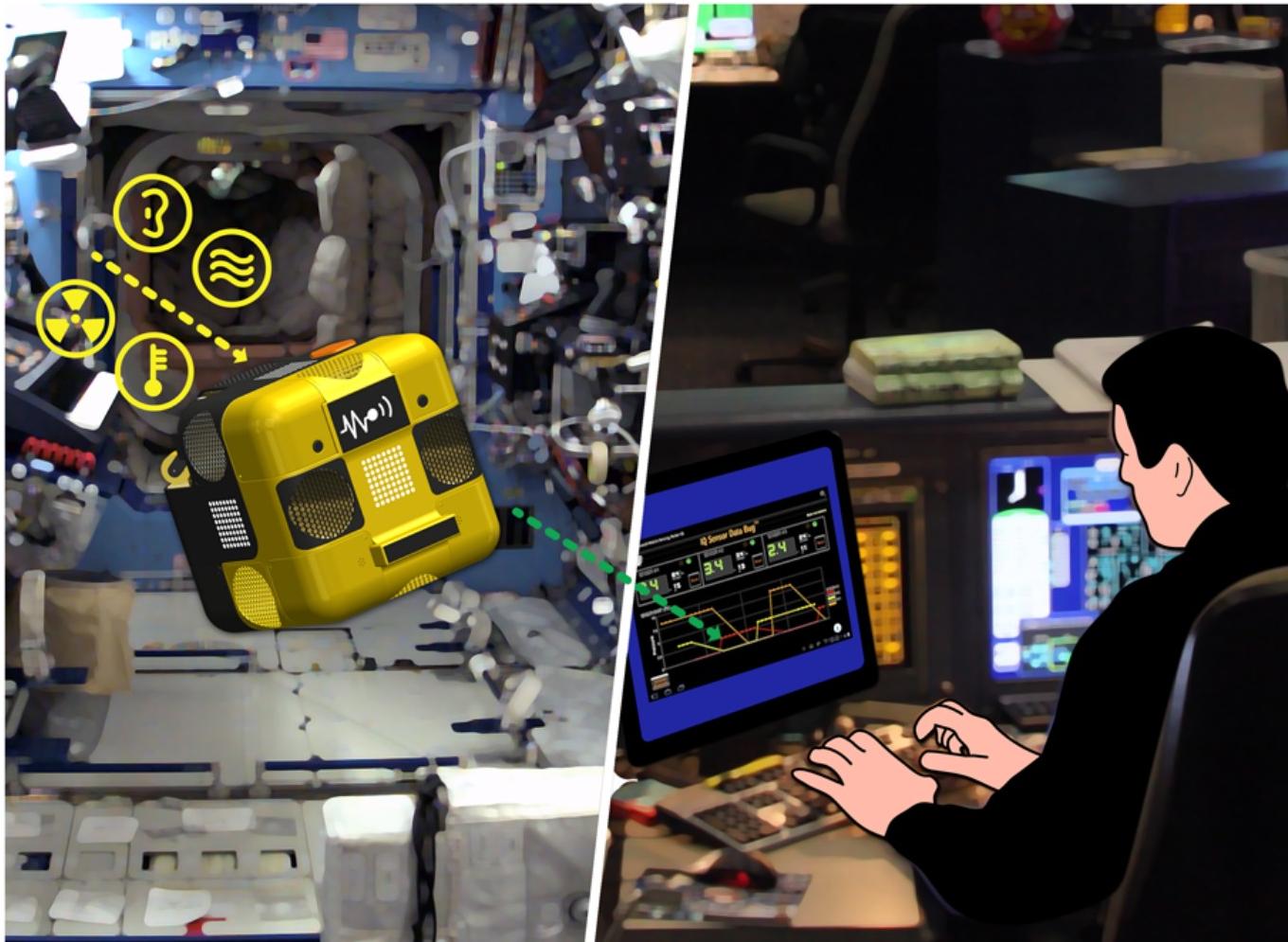
# Mobile Camera Tasks



ISS Program, FOD, POIC



# Mobile Sensor Tasks



ISS Program, FOD, POIC

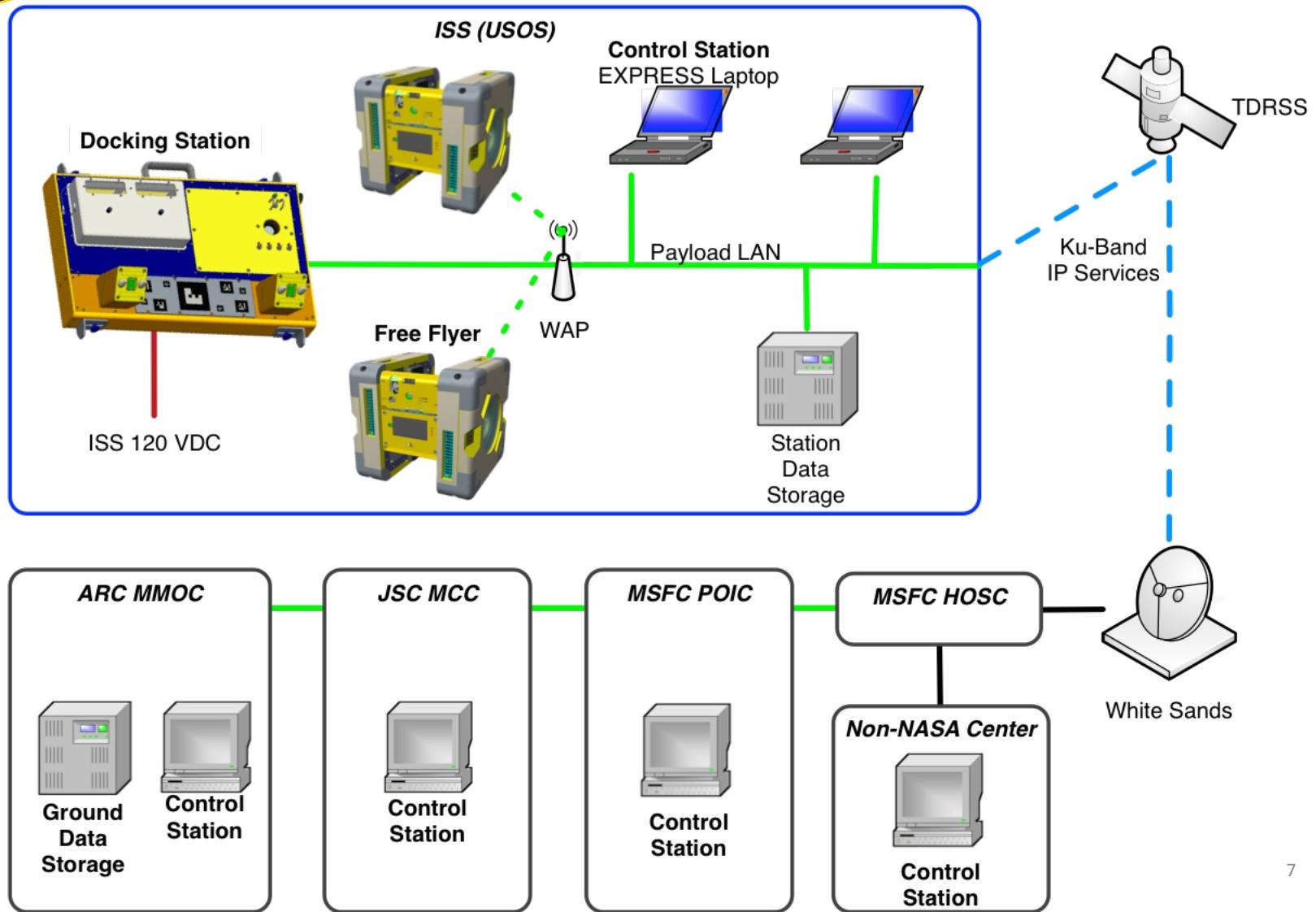


# Dock & Resupply





# System Architecture

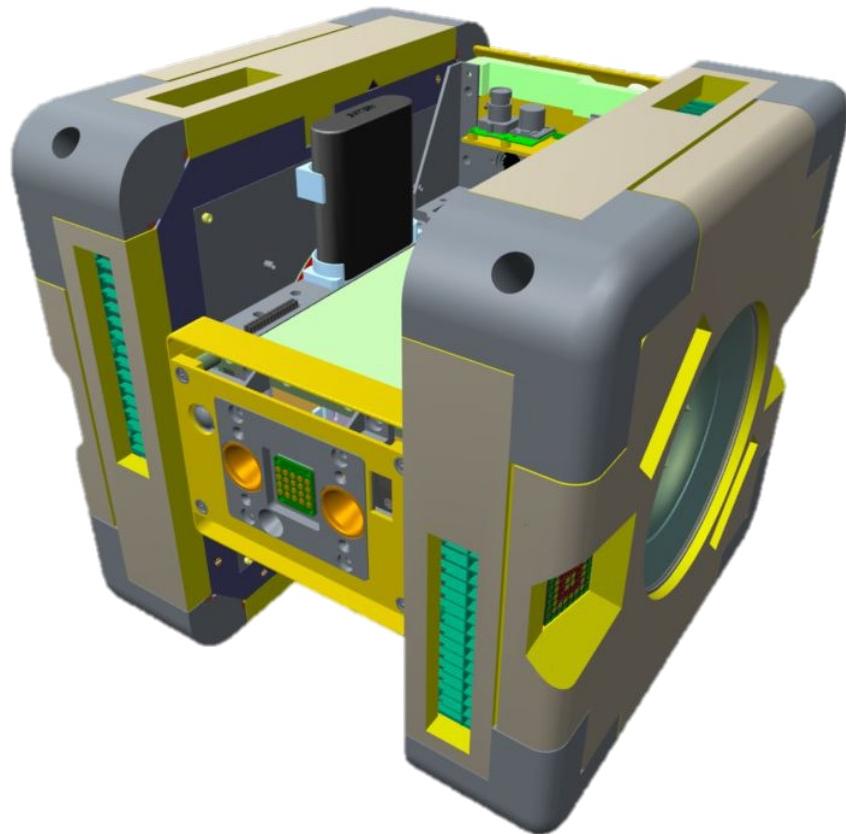




# Astrobee Free Flyer



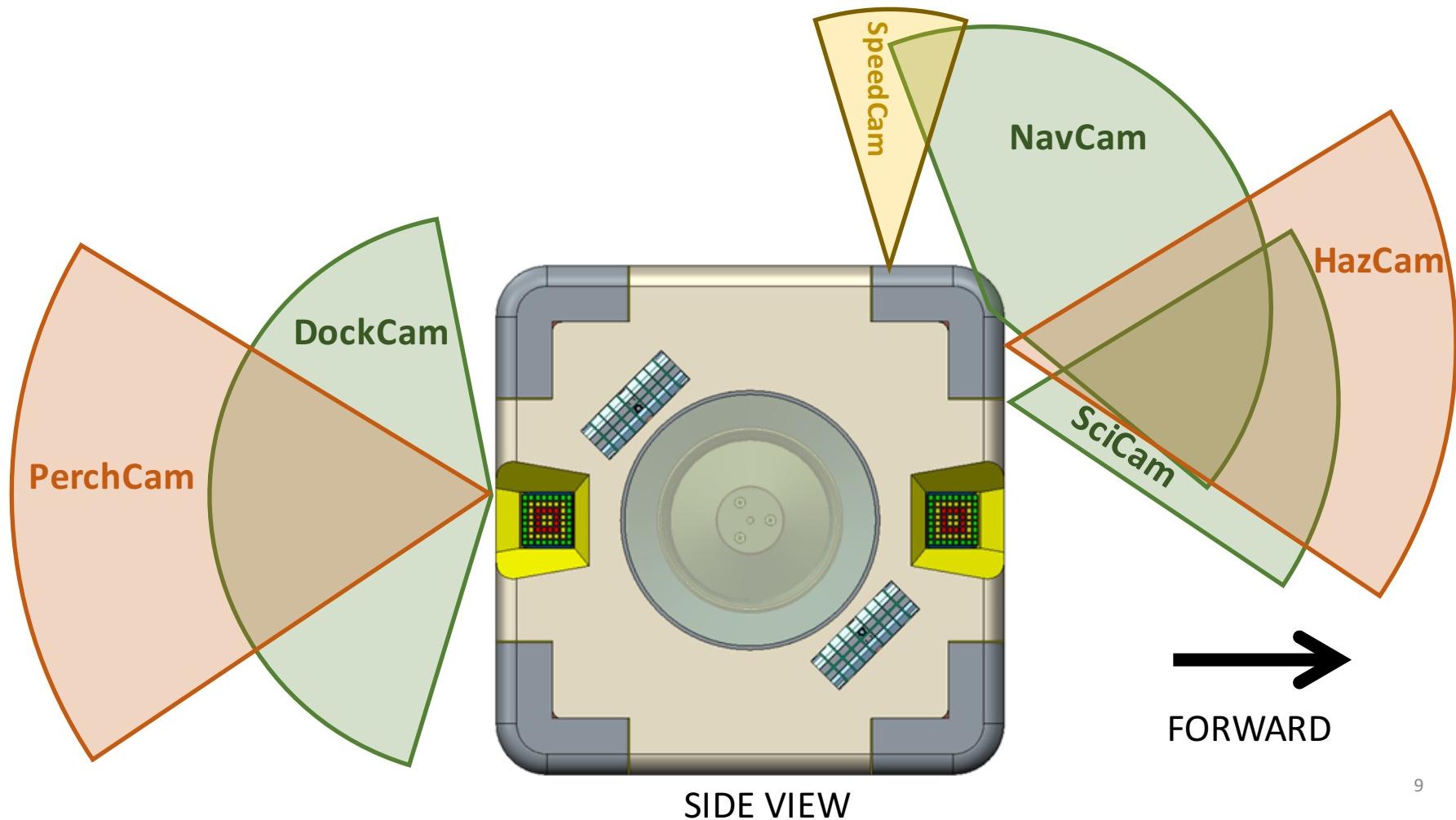
Forward Top



Aft Top

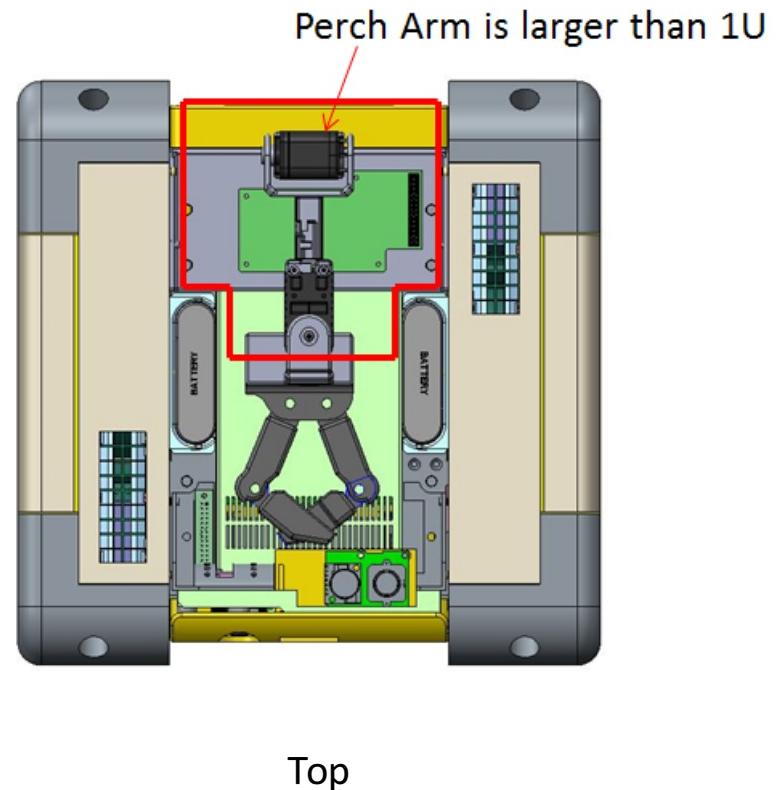
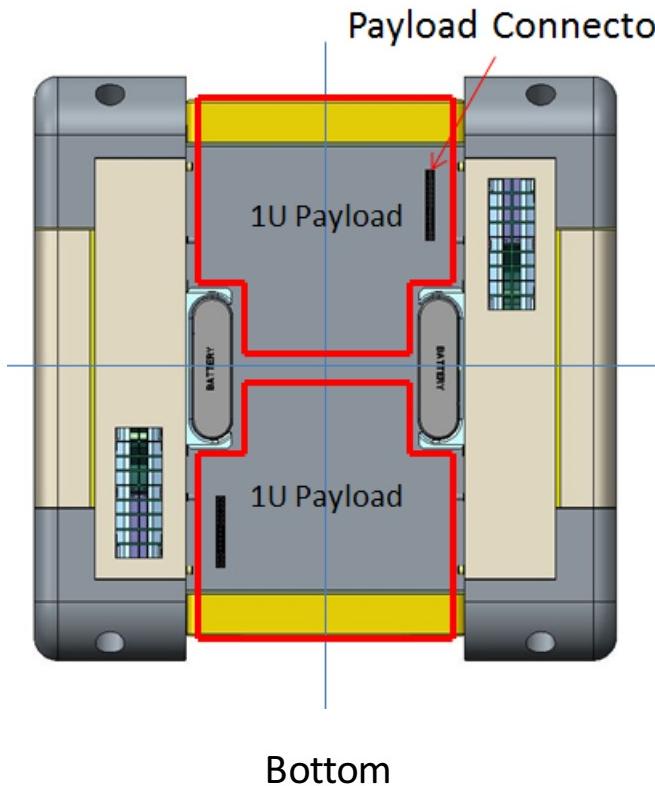


# External Sensors



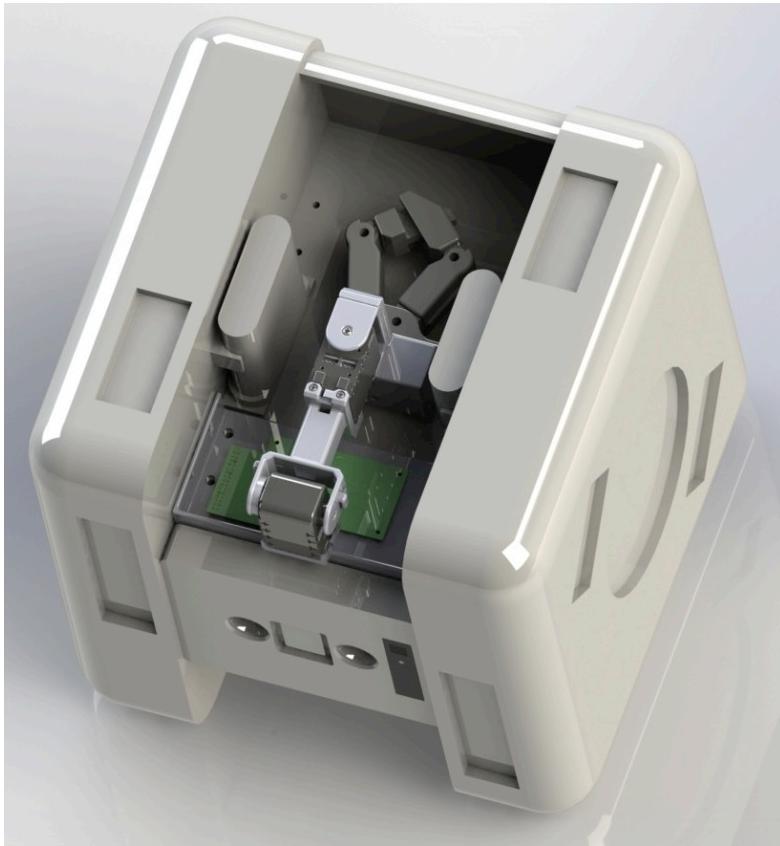


# Payload Layout

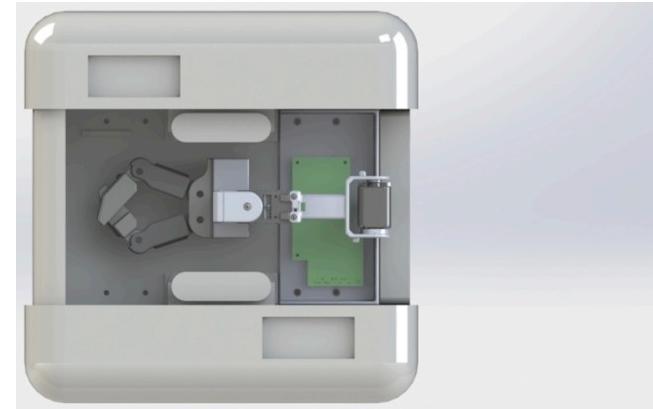




# Perching Arm



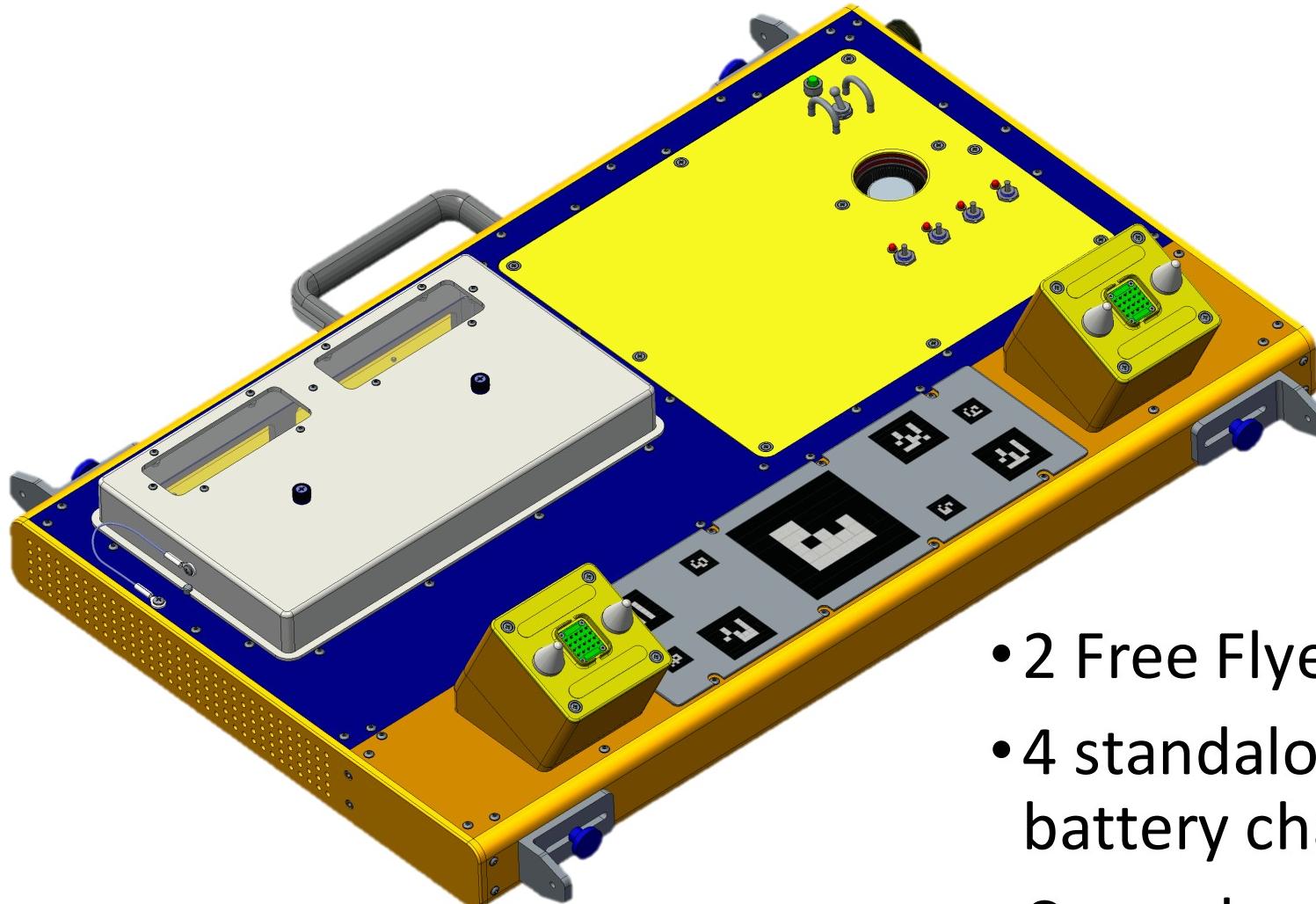
Stowed



Stowed/Deployed



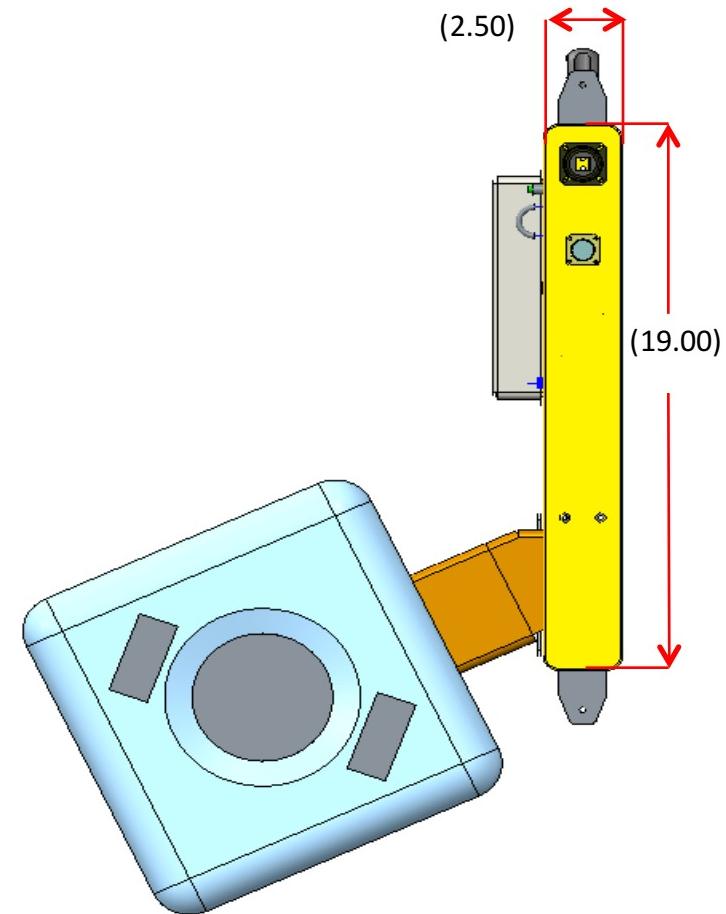
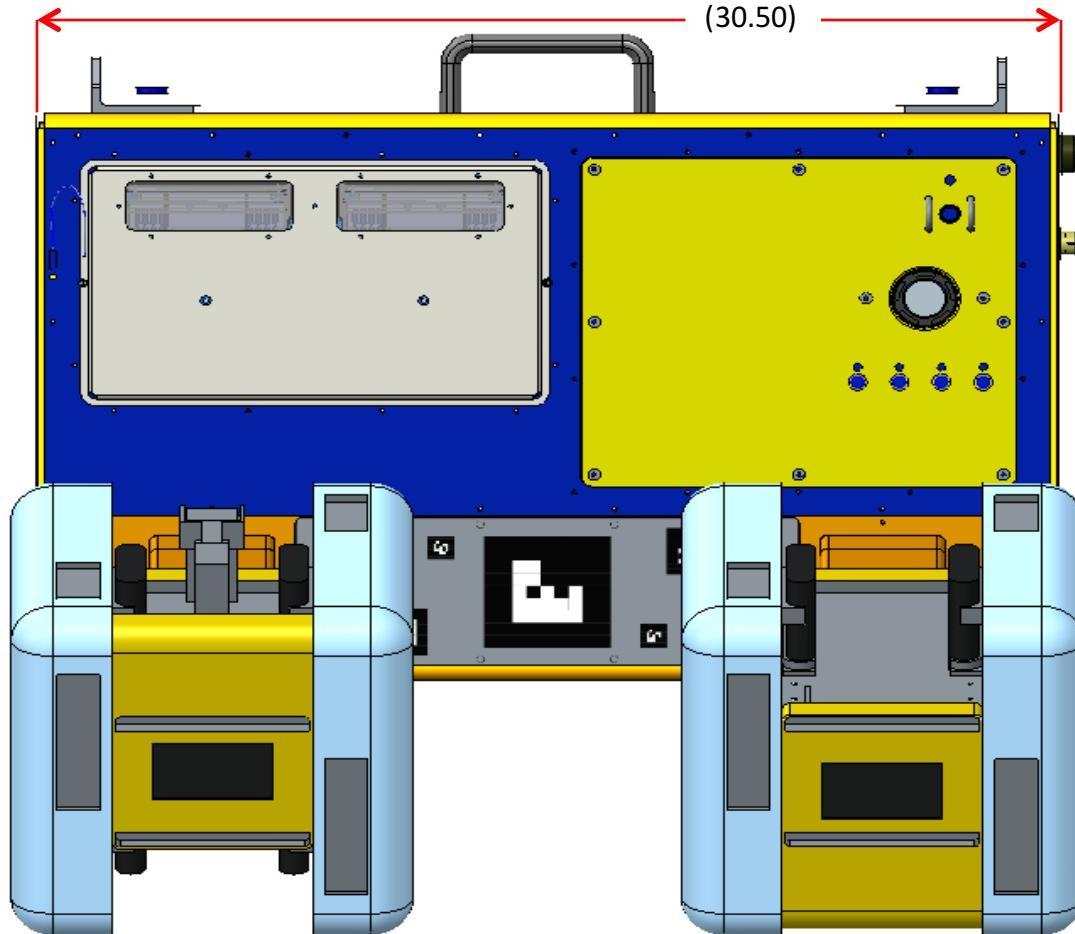
# Docking Station



- 2 Free Flyer berths
- 4 standalone battery chargers
- Control panel



# Docking Station Front and Side View



NOTE: Dimensions are in inches

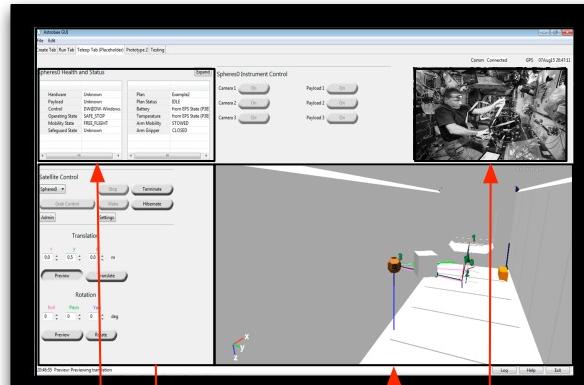


# Control Station

- Eclipse based GUI
- Create, run, tele-op plans
- Run guest science
- Administration
- Separate ground UI for file transfer, software updates and diagnostics



Distributed Video



Robot Status  
Telemetry

Teleop  
Commands  
Nav & Plan  
Telemetry

Navcam  
Images  
@1Hz



Scicam  
Real-time  
HD Video

Full Real-time Stream



# Plan Validation

Plan Editor Run Plan Teleoperation Guest Science Advanced

Comm Not Connected GPS 01Jun16 23:00:39

Plan Editor

Plan Name AADemo  
Estimated Duration 00:11:02

Validation Not Validated

Plan Step Duration

|             |          |
|-------------|----------|
| ▼AADemo     |          |
| 0 Station   | 00:01:23 |
| 0-1 Segment |          |
| 1 Station   | 00:01:44 |
| 1-2 Segment |          |
| 2 Station   |          |
| 2-3 Segment | 00:01:41 |
| 3 Station   |          |
| 3-4 Segment | 00:02:41 |
| 4 Station   | 00:02:20 |
| 4-5 Segment |          |
| 5 Station   | 00:01:13 |
| 5-6 Segment |          |
| 6 Station   |          |

3 Station

Location Based Coordinate Based Bookmarks Commands

X 5.78 Y -0.19 Z -0 m  
Roll 0 Pitch 0 Yaw 0 deg

Ignore Orientation  
Tolerance 0.1 m  
 Drag to Translate  Drag to Rotate

Interactive Plan Viewer

Validation Failed

Potential collision in Segment 2-3. Please move Station 2 or Station 3.

OK

00:00:00 Message goes here



## Run Plan Tab

The screenshot displays the FreeFlyer software interface, which includes the following components:

- Top Bar:** File, Edit, View, Help, Plan Editor, Run Plan, Teleoperation.
- Health and Status:** Shows system status for FreeFlyerA, including Hardware (Nominal), Payload (Nominal), Software (Nominal), Control (Dw@dw-windows7-32), Operating State (Plan Execution), Mobility State (Free Flight), Safeguard State (-), and Plan (Bb).
- Fault Details:** A button to view fault details.
- Plan Step Table:** A table showing mission steps and their status. The table has columns for Plan Step, Duration, and Success. The steps are grouped under BB and 1-2 Segment. The 1-2 Segment row is highlighted in green, indicating it is currently active.
- Image Processing:** A section titled "Image #164" showing a processed image from the rapid\_imagesensor\_sample-science camera, displaying a field of blue and purple particles.
- Commands for: FreeFlyerA:** Buttons for Grab Control, Terminate, Wake, and Hibernate.
- Plan Management:** Buttons for File ..., Plan Name (C:\Users\DW\Document), Plan Valid (Green), Upload, Run, Stop, Pause, and Skip Step.
- Live Telemetry:** A 3D visualization of the flight path and target area. It shows a green trajectory line labeled "1-2" and a yellow cube representing the target or destination point.
- Bottom Right:** A "Reset View" button.



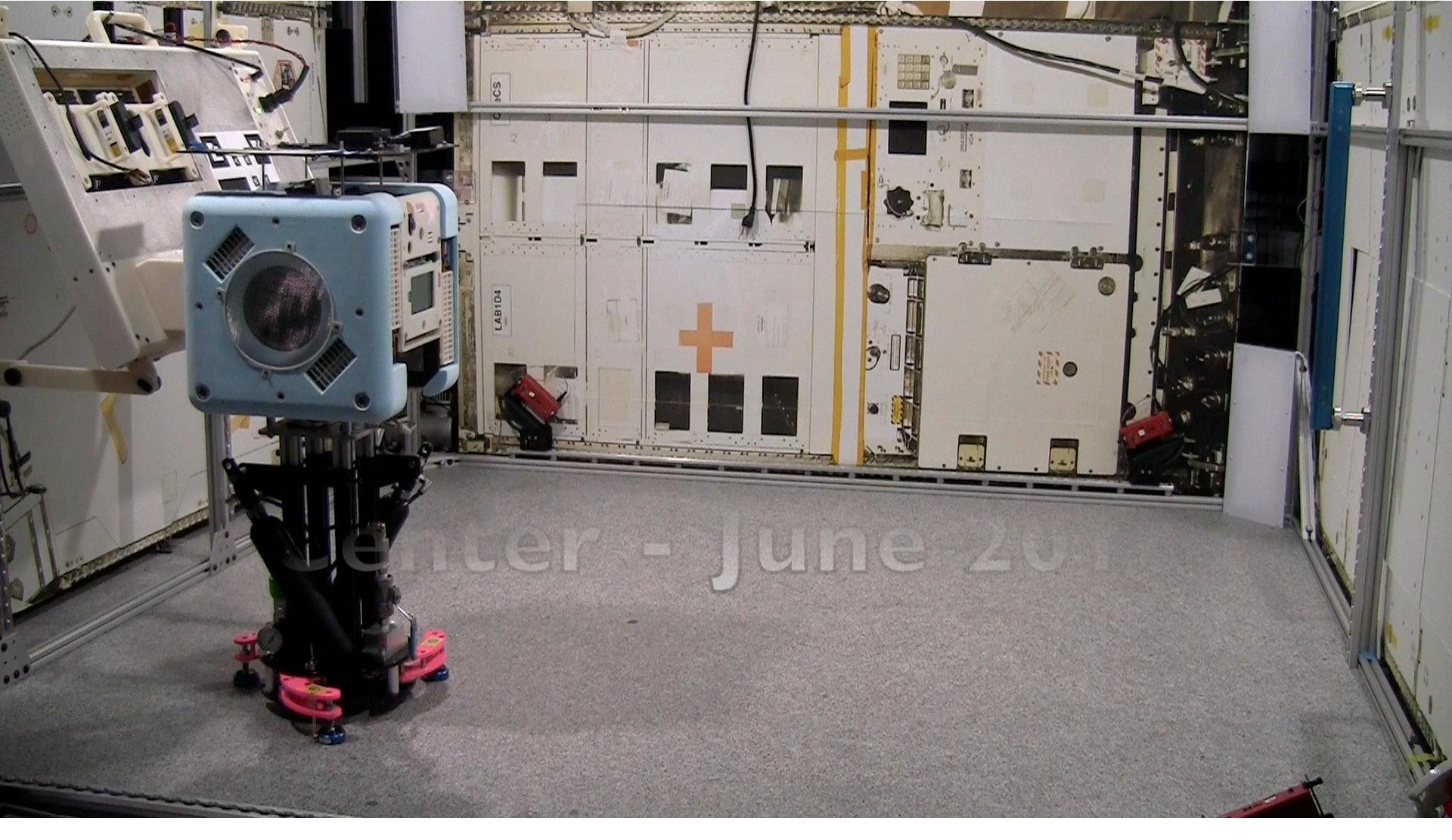
# Teleoperation Tab

The screenshot shows the FreeFlyer software interface with the following sections:

- Health and Status:** Displays system status for FreeFlyerA, including Hardware (Nominal), Payload (Nominal), Software (Nominal), Control (Dw@dw-windows7-32), Operating State (Safe Stop), Mobility State (Docked), Safeguard State (-), and Plan (-).
- Fault Details:** A button to view fault details.
- Instrument Control for FreeFlyerA:** Buttons to turn Camera 1, Camera 2, Camera 3, Payload 1, Payload 2, and Payload 3 On or Off.
- Info Label:** A placeholder for information, currently showing a camera icon labeled "RAPID".
- Commands for FreeFlyerA:** Buttons for Grab Control, Terminate, Wake, Hibernate, Stop, and Undock.
- Translation:** Sliders for AFT (1.0 to FWD), PORT (0.0 to STBD), and OVHD (0.0 to DECK). A "Reset Preview" button is also present.
- Rotation:** Sliders for Roll, Pitch, and Yaw.
- Arm Commands:** A checkbox for Show Preview and a Translate button.
- Live Telemetry:** A 3D simulation showing a robotic arm with a gripper interacting with a yellow rectangular object. The simulation includes a coordinate system (X, Y, Z) and labels LAB1P1, LAB1P2, LAB1P3, and LAB1D2, LAB1D3, LAB1D4.
- Teleop Command Log:** A text box for logging teleoperation commands.

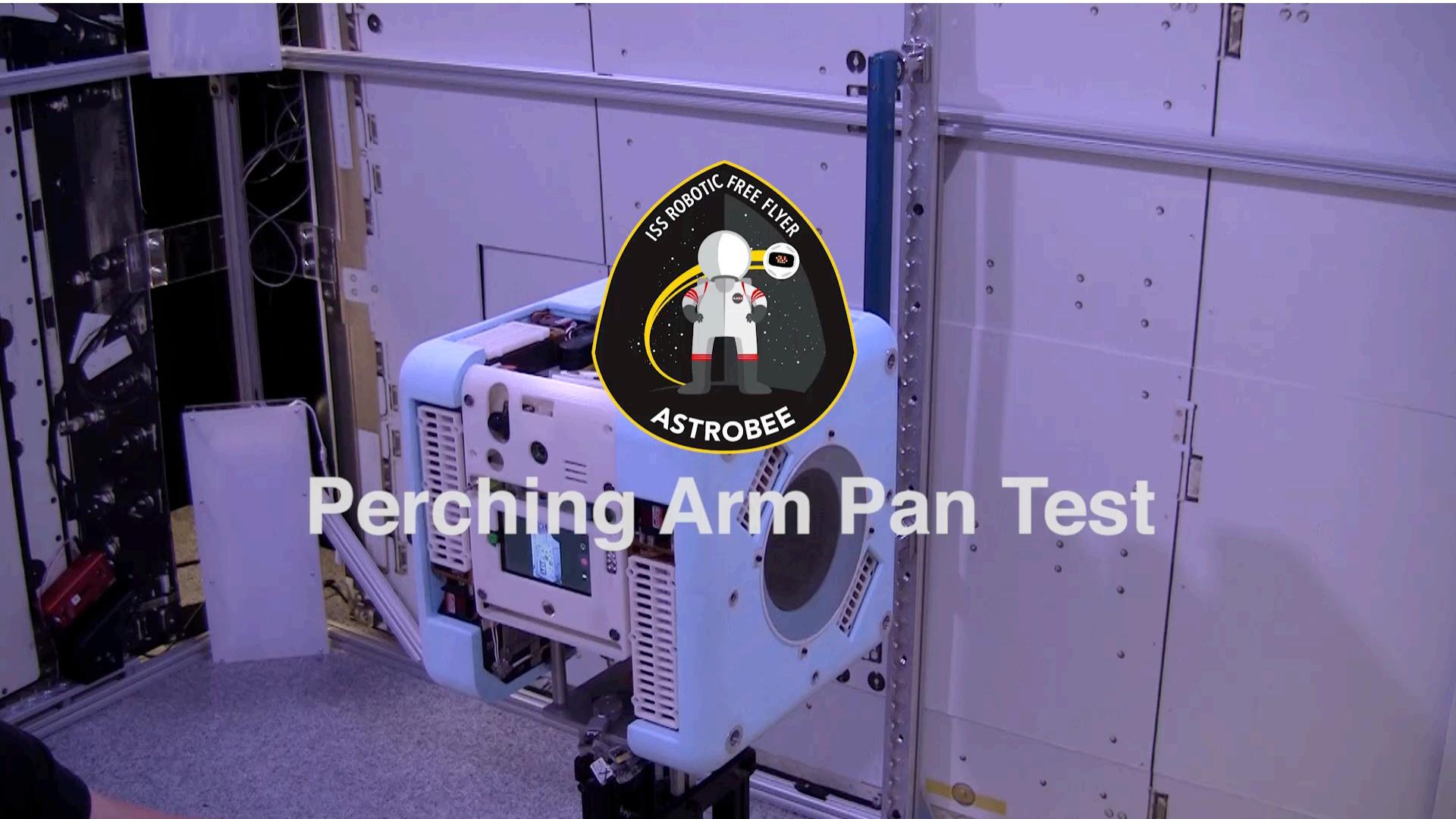


# Navigation Demonstration





# Perching Arm Demonstration



Perching Arm Pan Test



# Backup



# Base Layout

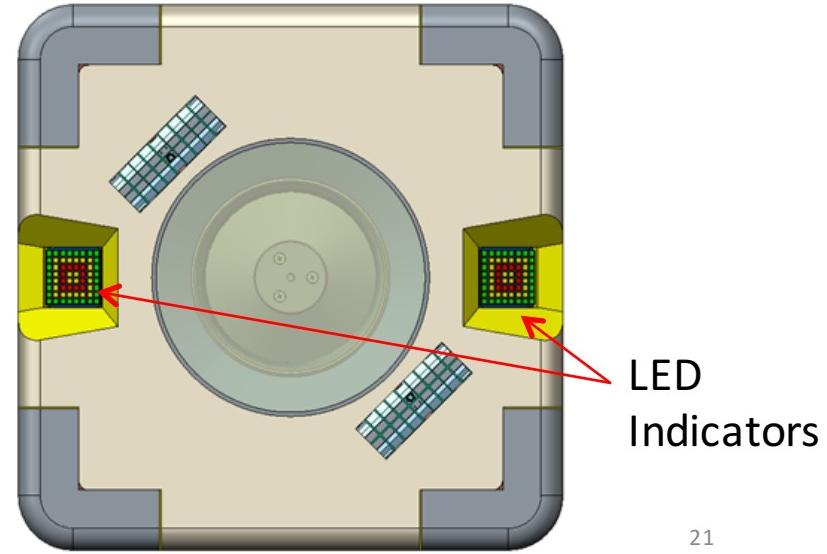
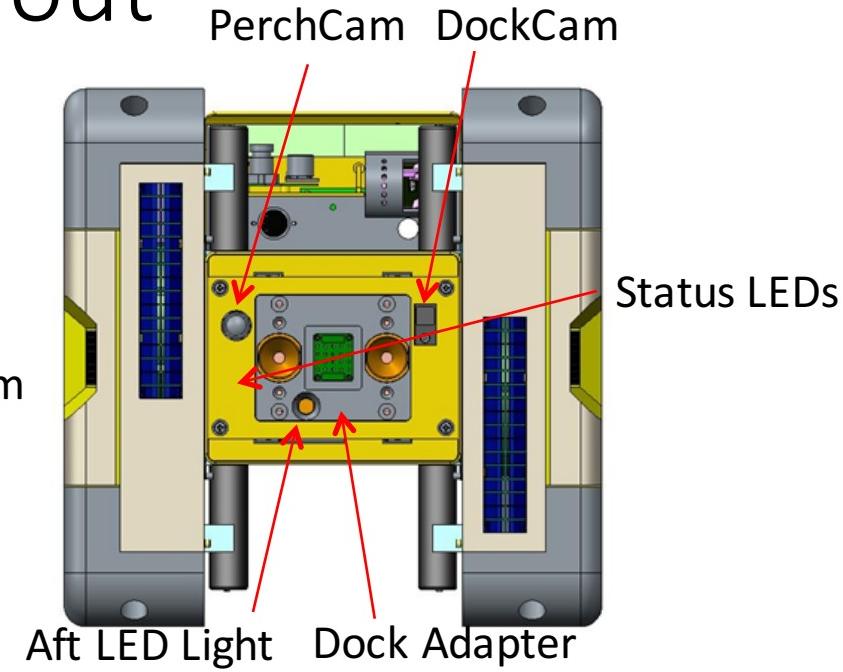
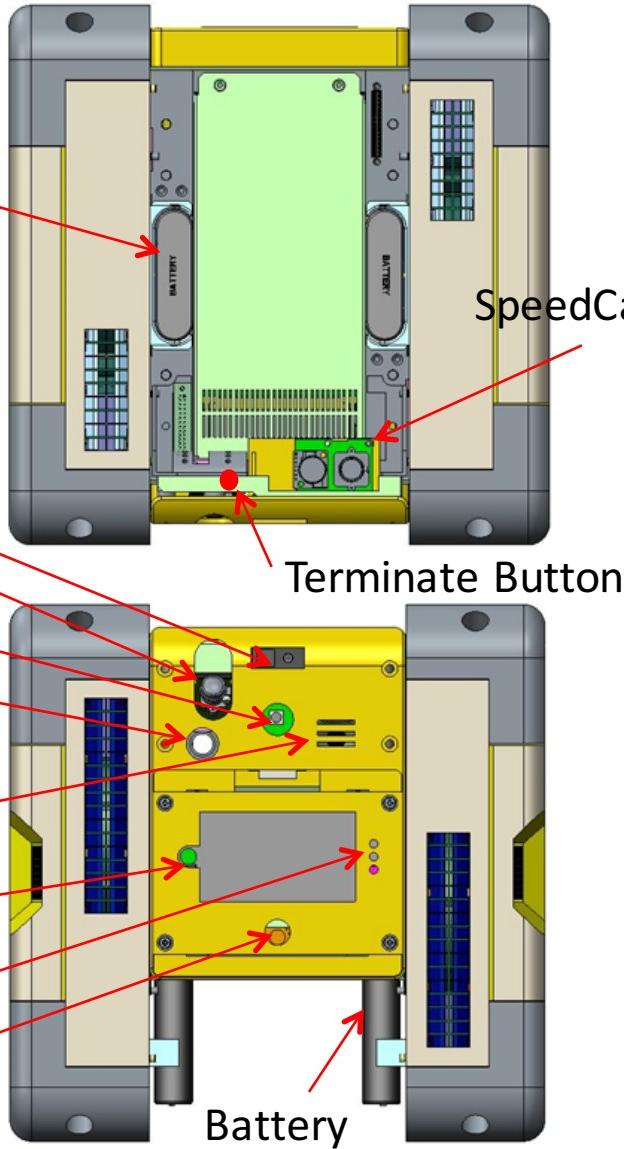
Battery  
(1 on top +  
1 on bottom)

HazCam  
NavCam  
SciCam  
Laser

Microphone /  
Speaker

Touch Screen /  
Touch Screen Activate Button

Status LEDs  
Front LED light





# Indicators

